

**DEVELOPMENT OF AN INFORMATION SYSTEM FOR THE MANAGEMENT  
AND THE PROTECTION OF THE FORESTS AS A LAND-USE.  
APPLICATION ON PENTELI MOUNTAIN.**

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**Abstract:**

Greece has experienced the disastrous consequences of many fires through the last years, which in many cases led to the alteration of the legislated land-use of the forests. A typical example was the great fire in Penteli Area in 1998, which is the study area of this project.

All the above, urged the development of a Land Information System for the management and protection of the forests (F.I.S.). A system involving registration, processing and utilization of data relative to forests, aiming to study them and preserve their use.

Data was gathered from almost every relevant source, civil services, local and private organizations, institutions, papers and magazines, etc. It consists of surveying and land-use maps, sequential aerial photos (before and right after the fire), statistical and demographic data, legislation on fires and reforestation, as well as info on previous fires in the same area.

The extents of the area burnt, vegetation species, contours, roads, built-up areas, local administration boundaries, counter-fire measures (water resources, guardhouses, etc.) and other information were categorized and classified into 5 thematic maps. Successive pictures and aerial photos, present lively the evolution of the study area through time.

The application was developed using ESRI's ArcInfo and ArcView, G.I.S. software.

The most important feature of F.I.S. is the unification of data collected from various sources, in different formats, created in different times with a range of accuracy requirements. This way, the user can easily combine a variety of information, superpose different sets of data and make decisions faster, more efficiently and inexpensively.

In the future, the database of F.I.S. could be expanded, including more information, multimedia data, etc. As well, the whole system could interact with the under-development National Cadastre, constituting the main registration and management tool for the forestland and the national environment in Greece.

## 1. LEGAL STATUS

The right to and the protection of the environment are two consolidated values, protected by the Constitution and a State obligation, connected to the human nature, like the right to life, freedom, equality and respect of the human dignity. The alteration of the purpose of the Public Forests and of the Forest Lands is prohibited. The restoration of the original forest nature of the lands which are destroyed or illegally deforested by human action or natural causes is imperative and it is expected the Forest wealth to be consolidated as social benefit which offers a lot of benefits to the community and is essential for the protection of the natural environment.

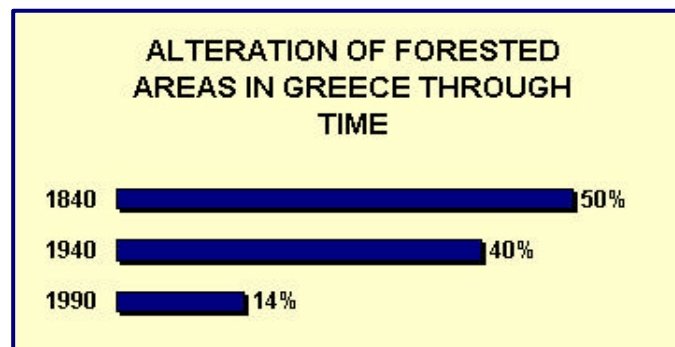
The relevant jurisprudence is described as follows:

- ✓ The 998/79 law is the basis for the forest protection. The definitions of the terms: Forest (public or private) and Forest Lands are based upon it. Also, it determines all the measures for the forest protection, the successful dealing with fires, the planting of new forests and the reforestations, the permitted operations in the Forests and the Forests Lands as well as the penalties for the actions against it.
- ✓ The 2664/98 law is about the National Cadastre and contains a particular and specific regulation for the Forests lands. The basic change to the existing legal status was about the determination of the terms Forest and Forest Lands. So, according to this law, new Forest maps are created, which after being declared final, have full probative value and from now on they determine the terms Forest and Forest Lands. So at any time it's possible to know their exact size and location and as a result there's a more successful confrontation of land grabbing.

## 2. FIRES IN GREECE

One of the most important reasons of the environmental destruction are the fires in the woods, which appear more often in Greece during the summer months.

In Greece in the last century, or even in the last decades, forests covered a wider area than they do now. The next chart shows clearly the substantial reduction of forests year after year.

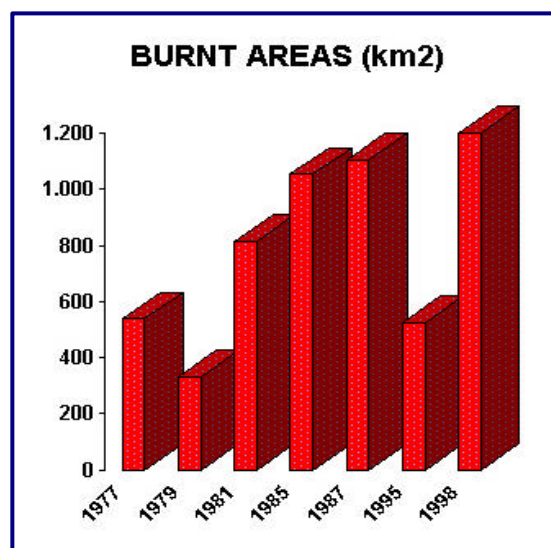


While this is the case in Greece, the number of Forests in other countries of the Southern Europe is much bigger. For example in Spain there is a rate of 33%, in Portugal 26.5%, in France 25.5%, in Italy 22% and in Bulgaria 32%.

Table 1, which follows, shows all the completely burnt down areas in Attica during the summer of 1998, presenting the extent of destruction. The same situation appears all over Greece. Statistically, it results that in 1998 the fires all over Greece covered the wider area ever, a fact that is obvious in the following chart.

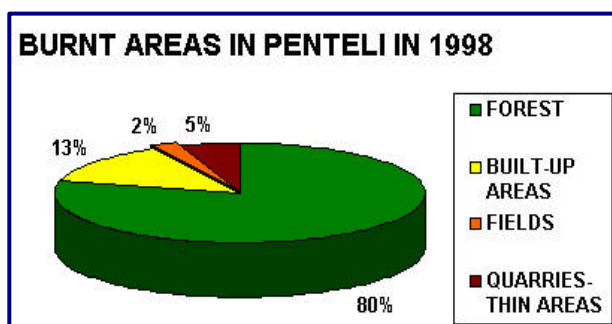
FIRES IN ATTICA REGION SUMMER OF 1998	
Area	Extent (sq.m)
➤ Penteli	75.500.000
➤ Rafina	2.933.000
➤ Helioupoli	3.372.000
➤ Lagonissi	22.273.000
➤ Salamina	1.936.000
➤ ThracoMacedones	596.000
➤ Avlonas	29.333.000
➤ Avlonas-Malakassa	23.707.000
➤ Dilessi	5.153.000
➤ TOTAL:	164.803.000

Table 1



## 2.1. Mount Penteli Fire in 1998

As it was mentioned above, the reason for the development of this project was the great fires that broke out in July and August 1998 in Penteli. The total burnt down area, covered 75.500.000 sq.m. It is also important to notice that in the great fire which had broke out in 1995 (68.800.000 sq.m) the burnt area was almost the same with the one in 1998. As we can see in the following diagram, 80% of the burnt area was forest, the 13% houses, 2% fields and 5% quarries and rigid areas.



It is obvious that except from the fire itself, the most important fact is the slower re-creation of the forests because of the big number of fires that have burnt Pentelikon Mountain. In Table 2 that follows, the dates of the fires and the burnt down areas on Pentelikon Mountain are mentioned.

DATE	AREA	EXTENT (sq.m.)
August 1982	Penteli	15.130.000
December 1986	Stamata	3.600.000
March 1988	St. Stefanos	435.000
April 1991	Stamata	5.306.000
September 1991	Agriliki	2.140.000
August 1993	Drafi	1.000.000
August 1993	Stamata – St. Stefanos	9.511.000
July 1995	Penteli	68.800.000
July - August 1998	Penteli	75.500.000

Table 2

### **3. STUDY AREA**



Palaia Penteli is a Commune since 1934, though it has a long history. Diggings, which took place in the Nymphaio area (a stalagmite cave) in Penteli, brought into light archaeological evidence dated since 310-350 B.C. The Parthenon marbles were taken from the ancient quarry. The history of Penteli is connected with the equally long history of the renowned Penteli Monastery, which was founded on about 1578. Other interesting sights of the area are the Castle of the Plakentia Duchess, the churches of St. Spyridon and St. Nicholas (7<sup>th</sup> century A.D.) the murals of which are of great archaeological value.

In nowadays Penteli has a populational and residential growth. The data, which was taken from the National Statistics Department, shows that during the 1991 census, the population of Nea and Palaia Penteli was up to 7.529 residents. In fact, in the Commune of Palaia Penteli alone, the population approaches the 10.000 residents. More and more residents of Athens choose Penteli as a permanent residence, a fact that can partially explain the attempts for the change of the main use (forest use) of the area.

#### **3.1. Whole of Area Burnt**

Administratively, the area burnt belongs to the Municipalities of Pallini, Pikermi, Rafina, Nea Makri, Gerakas and Dionysos as well as to the Communes of Palaia and Nea Penteli, Anthousa, Rodopoli and Stamata which are in the northeast of Attica. Its forests are attended by the Forest Inspection of Penteli.

The owners status, of the burnt down forest area, is one of the most serious problems of the area. It can't be solved for years while there is a big number of unsettled forest or other land-grabbing cases. As a first approach, the biggest part of the burnt down area, belongs to the public forest of the Penteli Monastery in the south of the region. The north part belongs to the public forest of Rapentosa, while a part of the area burnt is also part of a private forest.

Observations of the Anavryta meteorological station show an annual rainfall of 512mm. The maximum rainfall reached 142.5mm a day, storms occurred for 17.2 days per year, partial frost 4 days per year, total frost for 0.3 days per year. The lowest temperature was  $-6^{\circ}\text{C}$  and the highest  $44.4^{\circ}\text{C}$ . During the summer there are northeast winds.

The region is crossed by big streams especially of seasonal flow, received by the Big Stream that flows into Rafina and the Vagia Stream, which flows into the Marathon bay. The ground inclination is relatively wild.

Pentelikon Mountain has a forest road network, which was constructed in the last decades aiming to protect and make easier counter-fire and reforestation operations. Its density comes to 25.55 m/Ha, especially dense compared to the perfect density of forest road network, which is between 12-16m/Ha, as well as the specifications for protection against fire, which is 20m/Ha.

The dominating type of vegetation is pine in extended clumps. There are also many kinds of bushes. The vegetation maps of the region were designed before the fire and they indicate not only the type of vegetation but also which areas have been naturally or artificially reforested in the previous years.

The latest fire spread from a height of 180m in Pikermi to the height of 1.108m in Pyrgari (the highest peak of Mountain Pentelikon) southeast of Nea Penteli.

#### **4. FOREST INFORMATION SYSTEM (F.I.S.)**

##### **4.1. Data Collection**

The first stage of the project was to collect all the data related to the study area:

- ✓ The Penteli Forest Inspection Office provided the 1995 and 1998 limits of the fires, which were printed on a 1:50.000 Kifissia map of the Army Mapping & Geographical Service (A.M.G.S.). The fire limits set also the limits of the study area in the first stage.
- ✓ Aerial photographs were selected from the A.M.G.S, to cover all the study area (before and after the fire) so we can have a whole image of the results of the fire and of the development of the area during the years. The photographs were taken in 1962, 1973, 1989, 1996 and 1998 and refer to the Communities of Nea and Palaia Penteli as well as some areas in Drafi and Dionyssos.  
Also, four topographic diagrams on a scale of 1:5.000, covering the above mentioned areas were provided.  
Finally, from the same source we got a map on a 1:50.000 scale on which Pentelikon Mt. is depicted, as useful evidence to have a whole aspect of the area.
- ✓ The National Printing Office provided the issues of the Government Gazette which are related to the study of Penteli Forest Inspection Office, were published after the damage evaluation in order to declare the burnt area reforested and include 18 map sheets of the A.M.G.S. on a 1:10000 scale. On these maps the limits of the 1995 and 1998 fires and the areas that were declared reforested as well as the ones, which were exempted from the reforestation for various reasons, can be seen.  
Also, all the Government Gazette issues related to the legal status upon which the forest and reforestations are based were provided.
- ✓ The Forest Research Institute provided an orthophotoquad on a 1:20.000 scale, which marks the vegetation type of the study area, its density, as well as some basic land-use types. An additional information which appears on the map, is which areas were naturally or artificially reforested.

The same source provided forest counter-fire orthophotoquads of Attica, designed by the Ministry of Agriculture. These maps are on a 1:10.000 and 1:40.000 scale including various information.

- ✓ From the Organization for Athens, useful data in a digital form came out consisting of the basic map background (digitized from the A.M.G.S. map)
- ✓ From the German Archaeological Institute, maps of the Penteli area, dated back to 1870-1880 and designed by the German engineers Caupert and Mikhhofer were collected rather for historical reasons.
- ✓ From the Palaia Penteli Commune historical evidence was given for the Penteli area.
- ✓ The articles published in the days of the fire and the terrestrial photographs of the fire, came from newspapers records.
- ✓ Finally, the Ministry of Agriculture, provided the reforestation studies, made after the 1995 and 1998 fires.

#### **4.2. Data Elaboration**

After the data above was collected, the first step was to study every piece of information and determine what would and should be used.

- ✓ Data from the Athens Organization (contours, streams, municipality limits, trigonometrical points and coastline) was used directly without any more processing.

This didn't happen with the rest of the evidence, which was in printed maps format. So:

- ✓ The vegetation map of the Forest Research Institute was scanned, providing 27 levels of information regarding vegetation types, land-use, trigonometrical points and the coastline, which were used for the registration of the background.
- ✓ The limits of the 1995 and 1998 fires were digitized from the 1:50.000 Kifissia map of the A.M.G.S. on which they were drawn, creating two new levels of information.
- ✓ Among the forest counter-fire orthophotoquads of Attica, those which cover the Palaia and Nea Penteli area on a scale of 1:10.000 were selected. The pieces of information used were the road network, the housing settlements, all the local counter-fire protection measures (fire plugs, tanks, water wagons) and general information such as district names, churches and monasteries, hospitals, squares and tourist sights.

They were registered to the background using the trigonometrical points coordinates, resulting to the appropriate modification of the mapping data and to the creation of a multi-level digital information map in AutoCad R14 environment.

Furthermore, pairs of aerial photographs of the same area taken in different times were selected to easily spot the differences on the fire effects, as well as the residential development of the area. These were scanned and orientated through Corel Draw 8 and Corel PhotoPaint 8 software, so as to have distinguished spots and locations of interest put on them. Ground pictures of the fire as well as of various locations in Penteli were also added, in order to enrich the system with extra audiovisual information.

### 4.3. Structure of the system

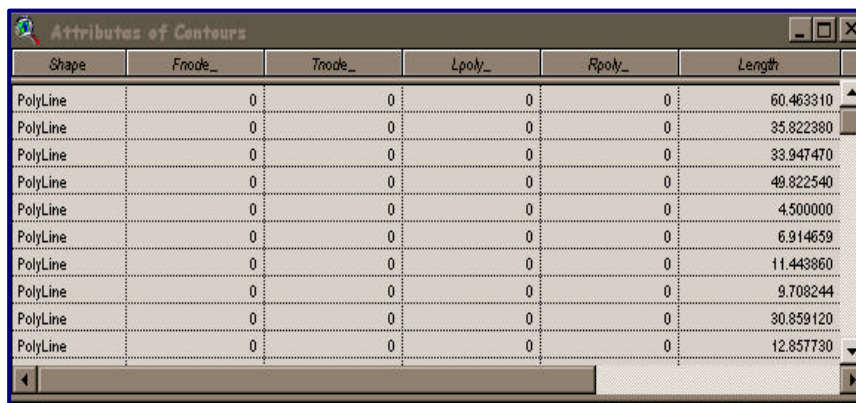
The following information levels have been selected, converted into ArcInfo coverages and inserted into ArcView 3.0a:

1. Trigonometrical points
2. Municipalities limits
3. Coastline
4. 1995 fire limits
5. 1998 fire limits
6. Contours
7. Streams
8. Road network
9. Counter-fire control points
10. Churches and monasteries
11. Housing settlements
12. Distinguished spots  
(squares, hospitals, archaeological sites).

### 4.4. DataBase Structure

New fields were added to the system's Tables, in order to update the DataBase on each information level:

- ✓ Altitude of the trigonometrical points and the contours, (basic ones per 100m, auxiliary ones per 20m).



Shape	Fnode_	Tnode_	Lpoly_	Rpoly_	Length
PolyLine	0	0	0	0	60.463310
PolyLine	0	0	0	0	35.822380
PolyLine	0	0	0	0	33.947470
PolyLine	0	0	0	0	49.822540
PolyLine	0	0	0	0	4.500000
PolyLine	0	0	0	0	6.914659
PolyLine	0	0	0	0	11.443860
PolyLine	0	0	0	0	9.708244
PolyLine	0	0	0	0	30.859120
PolyLine	0	0	0	0	12.857790

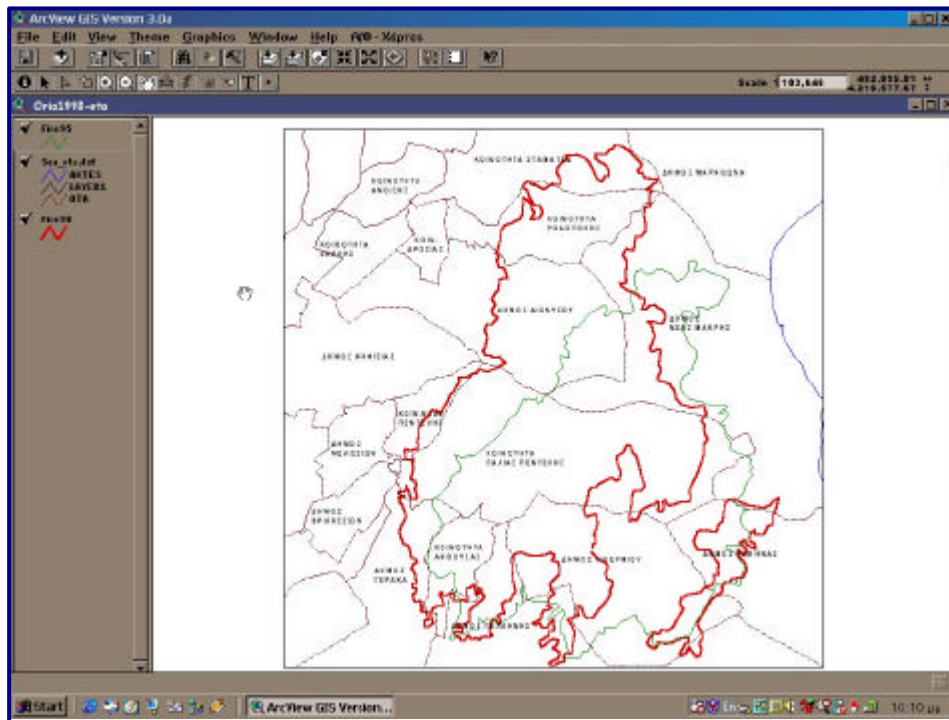
Attribute table example

- ✓ Names of the major Streams, House settlements, Churches, Monasteries and distinguished spots (squares, hospitals etc)
- ✓ Vegetation type.
- ✓ Street names and categories: a) main roads, b) asphalted roads, c) dirt roads, d) rough dirt roads.

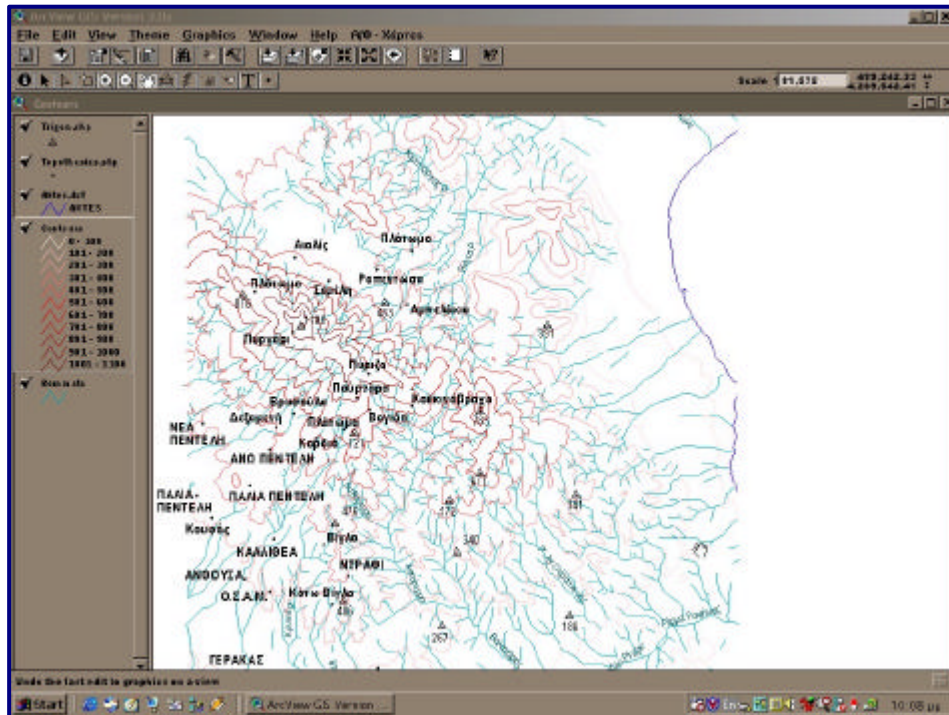
### 4.5. Thematic Maps Selection

The next step of the process was to group the above information levels, so as the relevant thematic maps to be created. Four thematic maps (views) were created with the following contents:

- ✓ *Local Authorities*, with their limits, the coastline and the limits of the 1995 and 1998 fires. This view was created to provide an initial evaluation of the extent of the 1998 fire, to show its relation to the one in 1995 and to determine the administrative boundaries of the injured areas.

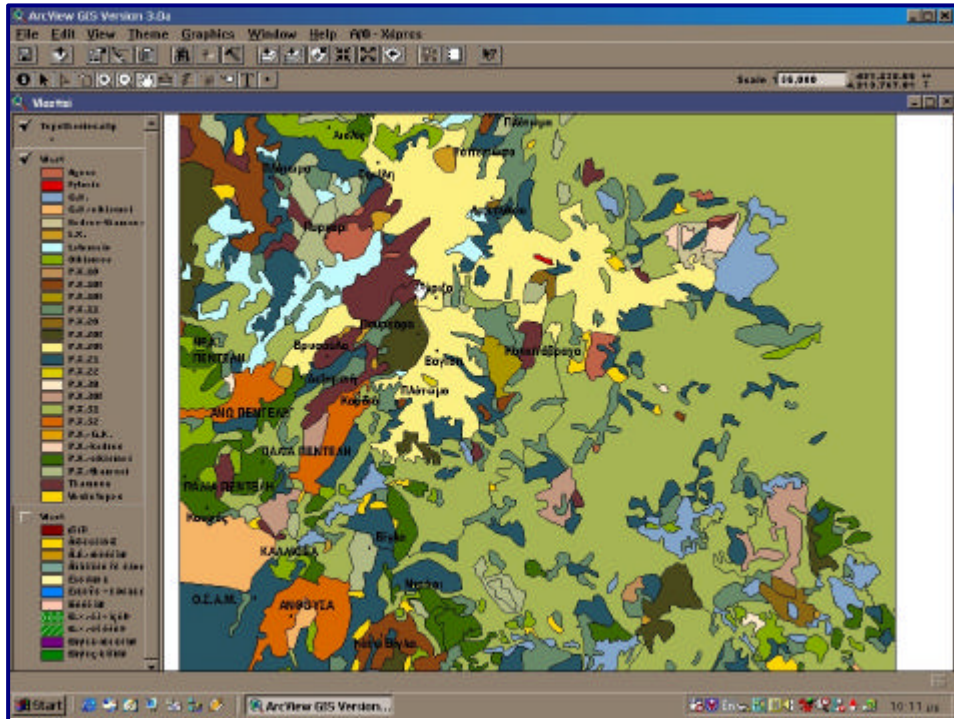


- ✓ *Surveying*, including the contours, the streams, the coastline, the names of the housing settlements, the main roads and the streams. It aims to show the topography of the area burnt.

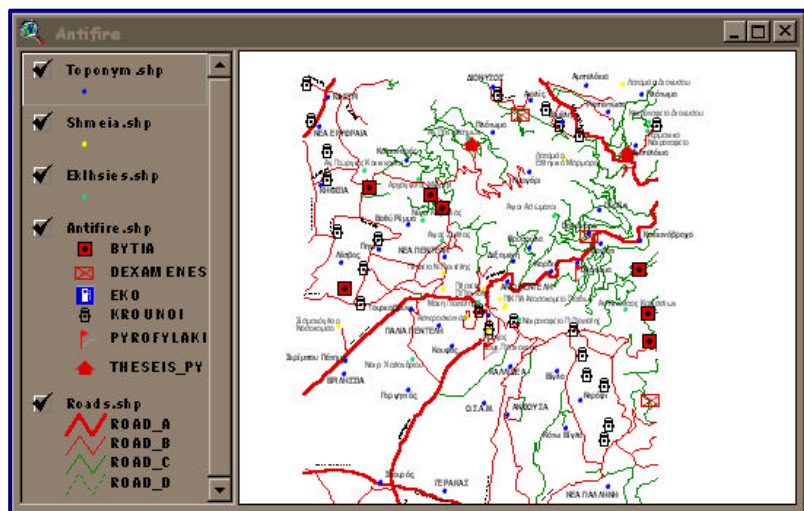




- ✓ *Vegetation*, including the vegetation types (as generalized as possible) and the housing settlements in the whole area burnt.

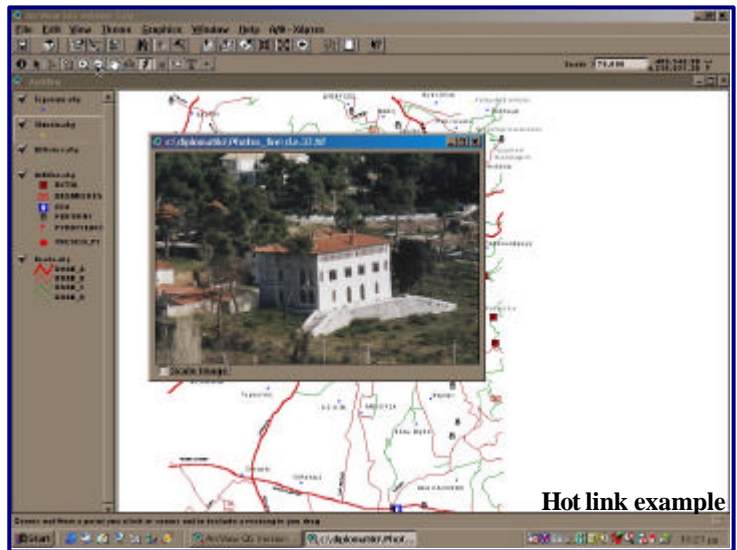


- ✓ *Counter-fire*, including the spots where counter-fire measures have been taken, the road network, the settlements, the names of the places, the distinguished spots of the area (squares, hospitals, archaeological sites, etc.) and the churches, monasteries and cemeteries in Palaia and Nea Penteli region alone. In the DataBase, a new field containing the relevant terrestrial photographs was added (hot links) in the settlements, churches and distinguished spots tables.

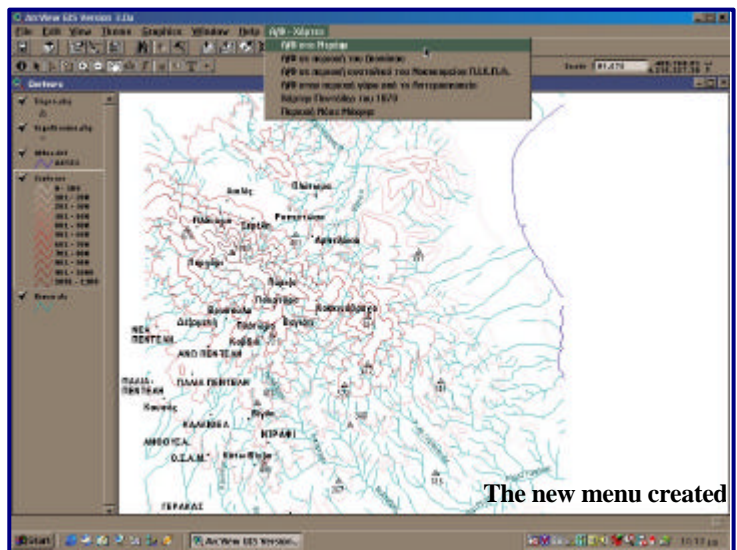


#### 4.6. Description of the System

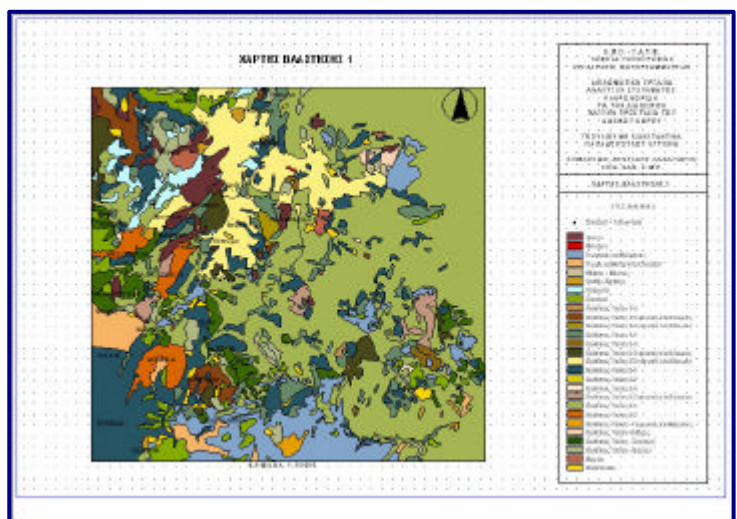
Entering the F.I.S, someone can choose one of the above views, depending on the kind of information he's interested in. In this point, we must make clear that during the F.I.S. development, special attention was paid to the data collection from many scientific resources, various sources, incompatible to each other and covering the whole extent of the subject, as well as to their processing. Making the system user-friendly (G.U.I. editing and automations development) was the second more important task, leaving though the possibility of further enrichment of the system with such tools. So, one should be elementarily acquainted with using the Arc View tools, in order to get the desired results from the system's operation.



By opening the theme tables it's possible for somebody to see the places where photographs have been inserted and to call them by pressing the hot link button as we can see in the picture above:



An alteration in the main program utilities is the creation of a script, which can project a combination of aerial photographs accentuating the year after year changes in the study area. These pictures are called through a new menu named: "AERIAL PHOTOS – MAPS" which, presents the available aerial photographs and the map of Penteli by Kaupert (1870), displays them for 20 sec and then closes them automatically.



Finally, five layouts (maps ready to print) were composed, resulting from the thematic maps existing in the system, which are the following:

- ✓ Limits of the 1995 & 1998 fires
- ✓ Counter-fire measures
- ✓ Surveying map
- ✓ Vegetation 1
- ✓ Vegetation 2

## 5. CONCLUSIONS - SUGGESTIONS

### 5.1. Enemies and Hazards of the Forest

An important part of a natural catastrophe evaluation process (such as a fire), is tracking down the causes, the most important of which are the following:

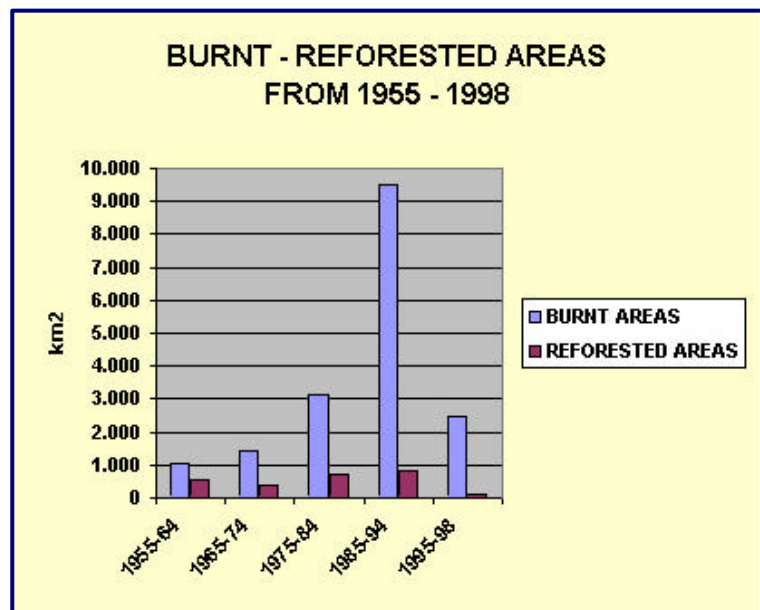
- ✓ Negligence or any kind of human mistake.
- ✓ Accidental events, as left in the forest garbage inflammation.
- ✓ Poor maintenance of insulators or other parts of the Public Electrification Company equipment.
- ✓ Intentional arsons, aiming to the deforestation and then exploitation in any way of the forests, which is the most usual reason.

Apart from the above causes, which directly start a fire, there are many other factors resulting to the poor protection and destruction of the forests. The main factor is the non-existence of a Forest Cadastre. The State doesn't know its own property, thus it is unable to defend it satisfactorily. A typical example is the decision of the Supreme Court 20 years ago, according to which, more than 60 million square meters of forest in Penteli were definitely lost for the State (usucaption appealed). There is a recent case of a trespasser, who was using a fake contract of 1936 and appeared to be the owner of 2.500.000 square meters of forest, which became building grounds and were sold just one month after the great fire of 1995 in Penteli. According to data from the Forest Inspection Office, 160 arbitrary buildings have been recorded in private and 75 in public forests in the Penteli area, situation that is becoming even worse considering that many of them are becoming legalized.

It is worth to mention that the situation above is aggravated, if the anticipated strict procedure of reforestation (according to the law) is not followed after a fire. Penteli is a typical example, where after the great fires of 1998 the burnt forest covered about 60.000.000 sq.m, though only 25.850.000 sq.m. were to be reforested, and according to a study of the Ministry of Agriculture just 6.528.000 sq.m. were finally selected as shown in the adjacent diagram.

Another factor, which makes reforestations ever harder, is the uncontrollable graze. In order to have the desired results, the reforestation area borders and the intensity of graze should be determined with special care in these areas, appropriately briefing the stockbreeders.

Finally, there are factors which result to the inefficient forest protection, such as the poor maintenance of the counter-fire zones as well as of the forests themselves and the confusion of responsibilities among the various forest relative authorities, which make the coordination of emergency situations extremely difficult.



## **5.2. Using F.I.S. to Protect the Forests**

The contribution of F.I.S. to the protection of forest areas, mainly guarantees the gathering and organizing of all the relative information, like data on every forest, sensitive and unsafe areas, previous fires and reforestation. If extra information about fire prevention and suppression planning is added, then the project can apply to the following subjects:

- ✓ Management of forest areas (providing a complete view of every forest land)
- ✓ Fire prevention and suppression, giving the possibility of prediction and immediate reaction – planning an action play, minimizing this way the size of destruction)
- ✓ Bridging among Authorities like Forest Inspection Offices, Local Authorities, Fire Departments, etc. aiming to provide flexibility in case of emergency.

Properly improving the system on user-friendliness, enriching it with other data coming from various sources and scientific fields, could make it become a very useful tool interacting of course with the Forest Cadastre. This would assist the effective management and protection of the forest areas, not only in Penteli, but also all over Greece.

## **5.3. Conclusions**

From all the above, it is clear that it's absolutely necessary to have an organized framework of managing and protecting forests. The first step of this framework's realization is undoubtedly the application of the Forest Cadastre, in order to solve the complicated ownership status and to be able to reforest any accidentally burnt forest area with accuracy. Then, the forests can be monitored through periodical aerial photographing or satellite images.

Paying more attention to the prevention and not to the suppression of fires is very critical, considering that in addition to the destruction of forest areas, the operation of fire suppression is extremely expensive for the state.

The forests are one of the most important natural ecosystems on the planet, covering vital needs apart from just recreational ones. So, people ought to respect and protect them individually or in an organized level, in order to enjoy the quality of life they offer.